Document No: GF20NNFCPC *Date:19/08/2026*

Issue No :01 Version No: 01

Process Capabilities: NNFC

Centre for Nano Science and Engineering (CeNSE)

National Nano Fabrication Centre (NNFC)

Document No: GF20NNFCPC

Issue No:01 Version No: 01

Revision History

Version No	DATE	AUTHOR	REVIEWED	APPROVED
00	*08/07/2025*	TM	COO	Chair NNFC committee
01	19/08/2026	TM	COO	Chair NNFC committee

Contact Details

Name	Designation	Contact Number	Email ID
Gajendra M	COO	NNFC office **2293-3319** Extension: **113**	gajendram@iisc.ac.in

☐ Confidential ☐ Internal ☒ Public

NOTE: *As a user of the NNFC you are responsible for reporting any activities that deviate from normal behaviour. The violator(s) may lose cleanroom access based on the discretion of the NNFC management.*

List of Abbreviation

Abbreviations	Definitions
CMOS	Complementary Metal-Oxide-Semiconductor
ET	Equipment Technologist
FOM	Facility Online Management Software
FT	Facility Technologist
IISc	Indian Institute of Science
MEMS	Micro-Electro-Mechanical Systems
NEMS	Nano-Electro-Mechanical Systems
NNFC	National Nano Fabrication Centre
OLSEH	Office of Laboratory Safety Environmental Health
SAS	Senior Administrative Assistant
SOP	Standard Operating Procedure
TM	Technology Manager
UD	User Document
ACM	Admin Committee Meeting
INUP	Indian Nano Users Program
MD	Monitoring document
MNCF	Micro and Nano Characterisation Facility
MSDS	Material safety data sheet
TD	Tool Document
TRM	Technical Review Meeting

Contents

Terms and Conditions

1. **Scope of Information**
   The process parameters, capabilities, and performance metrics presented in this document are provided for reference and planning purposes. They represent typical values obtained under standard operating conditions at NNFC.
2. **Subject to Variation**
   All parameters listed are subject to variation based on process conditions, material properties, tool status, environmental factors, and other operational constraints. Actual results may differ from the values stated.
3. **User Responsibility**
   Users are responsible for verifying the suitability of the listed parameters for their specific process requirements. NNFC does not guarantee identical outcomes across different materials, designs, or processing sequences.
4. **Mandatory Consultation**
   Users **must discuss any deviations, uncertainties, or special requirements** related to the listed parameters with the NNFC facility team **prior to initiating any process**. Proceeding without consultation may lead to process failure, equipment issues, or compromised results.
5. **Approval for Deviations**
   Any deviation from the documented parameters requires prior review and approval from the NNFC technical staff. Unauthorized deviations will be considered a violation of NNFC operating policies.
6. **Liability**
   NNFC shall not be held liable for any loss of samples, performance deviations, or project delays resulting from the user's failure to consult facility personnel or from unapproved process variations.
7. **Document Updates**
   This document is subject to periodic revision based on new characterizations, tool upgrades, or operational changes. Users are responsible for ensuring they are referring to the latest version.
8. **Compliance Requirement**
   By using NNFC facilities, all users agree to comply with the terms stated in this document, including adherence to process protocols, safety guidelines, and communication requirements with facility staff.

1. Lithography:

1.1. Mask Writer tools capabilities

Specification	Heidelberg DWL 66+	Heidelberg µMLA	Heidelberg µPG 501
UV wavelength	405 nm	365 nm	390 nm
Resolution (Isolated)	≥600 nm	≥1 µm	≥1 µm
Line/Spacing	800 nm/800 nm	1 µm/1.5 µm	1 µm/3 µm
Substrate Size	5 mm X 5 mm to 228 mm X 228 mm (9 "Mask Plate)	5 mm X 5 mm to 150 mm X 150 mm (6 "Mask Plate)	5 mm X 5 mm to 127 mm X 127 mm (5 "mask plate)
CD Uniformity	≤70 nm	≤300 nm	≤ 300 nm
Exposure Mode	Standard, Overlay, Grayscale (128 level)	Standard, Overlay, Grayscale (128 level)	Standard, Overlay

Focus	Pneumatic, Optical	Pneumatic	Pneumatic
Exposure Source	Laser Diode, Class: 3B	LED	LED
File Format	GDSII, CIF, DXF	GDSII, CIF, DXF	GDSII, CIF, DXF
System for alignment	Overview camera, High resolution	Overview camera, High resolution	High resolution camera
Writing speed	13 mm^2/min	40 mm^2/min	50 mm^2/min
Stage Movement	Laser Interferometer	Bearing Movement	Bearing movement
Types of alignment	Top side, Bottom side	Top side	Top side
Stripe width	120 µm	240 µm	150 µm /300 µm
Substrate thickness	0.1 to 12 mm	0.1 to 12 mm	0.1 to 6 mm
Alignment accuracy	≤200 nm	≤ 500 nm	≤ 500 nm

1.2. Mask Aligner tools capabilities

Specification	SUSS Micro Tec MJB4 (*Manual*)	EVG620NT (*Semi-Auto*)
Lamp	Mercury Arc Lamp	Mercury Arc Lamp
Lamp Power	500 W	1000 W
Maximum Intensity (365nm filter)	18 mW/cm^(2)	36 mW/cm^(2)
Wavelength	365 nm (I-line) & 248 nm (DUV)	365 nm (I-line) & 248 nm (DUV)
Substrate Size	1 cm x 1 cm to 4" Wafer	1 cm x 1 cm to 6" Wafer
Minimum CD (365nm filter)	≥ 1 um	≥ 1 um
Exposure Mode	Contact, Proximity	Contact, Proximity
Types of alignment	Top side, Bottom side	Top side, Bottom side, Bond alignment
Bottom alignment	Infrared	Objective lens, Infrared
Alignment Mode	Manual	Manual, Automatic
Alignment accuracy	Top side : ≤1 um Bottom Side: ≥ 5 um	Top side : ≤1 um Bottom Side: ≥ 2 um Bond Alignment: ≥ 3 um
Stage Movement	Manual	Laser Interferometry
Max Substrate Thickness	4mm	

1.3. E-beam Lithography Tools capabilities

Specification	Raith Pioneer	Raith Eline
Filament	Thermal field emission gun	Thermal field emission gun
Energy	20 eV to 30 keV beam energy	20 eV to 30 keV beam energy
Aperture	7.5, 10, 20, 30, 60, 120 um	7.5, 10, 15, 20, 30, 60, 120 um
Pattern Processor	20 MHz high speed pattern processor (upgraded)	20 MHz high speed pattern processor
Substrate Size	Up to 20 mm square substrates	Up to 50 mm square substrates, 4" Wafer
Minimum CD	50 nm	Sub 50 nm
SEM	High resolution SEM	High resolution SEM
Exposure Mechanism	Stitch Field Exposure only	• Stitch Field Exposure • Fixed Beam Moving Stage (FBMS) • Modulated Beam Moving Stage (MBMS)
Stage Movement	Laser Interferometer	Laser Interferometer
Beam Blanking Response	1 ns	1 ns
Proximity error Correction Software	NA	Available with Monte Carlo simulations

1.4. Resist capabilities of OPL Tools

Tools / Resist	Heidelberg µPG 501		Heidelberg MLA		Heidelberg DWL 66+		EVG 620NT		MJB4	
	Isolated line in µm	***Line /Spacing in µm***	***Isolated line in µm***	***Line/Spacing in µm***	***Isolated line in µm***	***Line/Spacing in µm***	***Isolated line in µm***	***Line/Spacing in µm***	***Isolated line in µm***	***Line/Spacing in µm***
AZ5214E	≥ 2	≥ 2 / ≥ 2	≥ 1	≥ 1 / ≥1.5	≥ 1	≥ 1 / ≥ 1	≥ 1	≥ 1 / ≥1	≥ 1	1 / ≥ 1
AZ4562	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3
S1813	≥ 2	≥ 2 / ≥ 2	≥ 1	≥ 1 / ≥ 1.5	≥ 1	≥ 1 / ≥ 1	≥ 1	≥ 1 / ≥ 1	≥ 1	≥ 1 / ≥ 1
S1805	≥ 1	≥ 1 /≥ 2	≥ 1	≥ 1 / ≥1	≥ 0.6	≥ 0.8 /≥ 0.8	≥ 1	≥ 1 / ≥ 1	≥ 1	≥ 1 / ≥1
AznLof2020	≥ 2	≥ 2 / ≥ 2	≥ 1.5	≥ 1.5 / ≥ 1.5	≥1.5	≥ 1.5 / ≥ 1.5	≥ 2	≥ 2 / ≥ 2	≥ 2	≥ 2 /≥ 2
AznLof2070	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3	≥ 3	≥ 3 / ≥ 3

1.5. Resist capabilities of EBL Tools

Tools / Resist	Raith Pioneer		Raith Eline	
	Isolated line	***Line/Spacing***	***Isolated line***	***Line/Spacing***
PMMA 950 A4	≥ 100 nm	≥ 100 nm / ≥ 100 nm	≥ 100 nm	≥ 100 nm / ≥ 100 nm
PMMA 950 A2	≥ 50 nm	≥ 50 nm/≥ 50 nm	≥ 50 nm	≥ 50 nm/≥ 50 nm
PMMA 495 A4	≥ 250 nm	≥ 250 nm/ ≥ 250 nm	≥ 250 nm	≥ 250 nm/ ≥ 250 nm
maN-2401	≥ 50 nm	≥ 50 nm / ≥ 50 nm	≥ 50 nm	≥ 50 nm / ≥ 50 nm
maN-2403	≥ 120 nm	≥ 120 nm / ≥ 120 nm	≥ 120 nm	≥ 120 nm / ≥ 120 nm
MaN-2405	≥ 250 nm	≥ 250 nm / ≥ 250 nm	≥ 250 nm	≥ 250 nm / ≥ 250 nm
Csar 6200.13	-	-	≥ 200 nm	≥ 200 nm / ≥ 200 nm
Csar 6200.09	-	-	≥ 20 nm	≥ 20 nm / ≥ 30 nm

1.6. EVG 501 Bonder

Specification	EVG 501 Bonder
Maximum Substrate Size	4” (100mm) Wafer
Minimum Substrate Size	1cm x 1cm Square Sample
Maximum Voltage	-2000 V
Maximum Force	3500N
Maximum Temperature	420 degrees Celsius
Bonding Techniques	• Anodic Bonding • Fusion Bonding • Adhesive Bonding • Eutectic Bonding • Thermo compression Bonding
Maximum Current	50mA
Ultimate Vacuum	1E-5 mbar
Bond Alignment	Only for 4”, 3” and 2” wafers

1.7. Obducat NIL EITRE 6

Specification	Obducat NIL EITRE 6
Maximum Substrate Size	6” (150mm) Wafer
Minimum Substrate Size	1cm x 1cm Square Sample
Maximum Temperature	200 degrees Celsius
Maximum Pressure	80 bar
UV Light	LED 40 mW/cm^2
Minimum Feature Size	20nm Isolated Line
Imprint Technique	Soft press IPS technology
Alignment Accuracy	1um

Resist Capabilities for NIL tools:

Resist	Density of Pattern	Minimum Feature Size	Aspect Ratio
TU7 - 90	L/S - 50nm/50nm	50nm	1:2
TU7 - 440	L/S - 100nm/100nm	100nm	1:3.5
TU-7 - 900	Not Explored	-	-
TU-7 - 1250	Not Explored	-	-
IPS Repeatability		3 time, without the yield drop across 4" wafer	

2. Diffusion.

2.1. Oxidation Furnace

Description	Dry Oxidation	Pyrogenic Oxidation
Contamination Level	Level-1	Level-1
Pre-process	Level-1 RCA Cleaning	Level-1 RCA Cleaning
Substrates allowed	Silicon, Silicon Dioxide and Silicon Nitride	Silicon, Silicon Dioxide and Silicon Nitride
Sample Size	1cm x 1cm small samples to 150mm Diameter wafer	1cm x 1cm small samples to 150mm Diameter wafer
Batch Size	25 samples for sample size up to 100mm Diameter wafer 1 sample for sample size from 100mm to 150mm Diameter wafer	25 samples for sample size up to 100mm Diameter wafer 1 sample for sample size from 100mm to 150mm Diameter wafer
Maximum Temperature	1100^0C	1100^0C
Working Pressure	Atmospheric Pressure	Atmospheric Pressure
Available Gases	N_2, O_2 and N_2O	N_2, H_2, O_2 and N_2O
Standard recipes available	20nm, 50nm, 100nm and 150nm	200nm, 280nm, 300nm, 500nm, 1000nm and 2100nm
Thin Film specifications	Refractive Index: 1.46 @ 632nm wavelength Wet Etch Rate(BOE): ~70nm/min Film Non-Uniformity: ±3% across 100mm Diameter wafer and ±5% across a batch of 25 wafers (100mm wafers).	Refractive Index: 1.46 @ 632nm wavelength Wet Etch Rate(BOE): ~70nm/min Stress: 300MPa (Compressive stress) Film Non-Uniformity: ±5% across 100mm Diameter wafer and ±5% across a batch of 25 wafers (100mm wafers).

2.2. Diffusion Furnace

Description	Phosphorous Diffusion	Boron Diffusion
Contamination Level	Level-1	Level-1
Pre-process	Level-1 RCA Cleaning	Level-1 RCA Cleaning
Substrates allowed	Silicon, Silicon Dixode and Silicon Nitride	Silicon, Silicon Dixode and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	6 samples for sample size upto 100mm Diameter wafer	6 samples for sample size upto 100mm Diameter wafer
Maximum Temperature	1100^0C	1100^0C
Working Pressure	Atmospheric Pressure	Atmospheric Pressure
Available Gases/Doping source	N_2, O_2 and $POCl_3$	N_2, O_2 and BN-Disk
Standard recipes available	25 Ω/□	25 Ω/□
Thin Film specifications	Doping Non-Uniformity: ±5% across 100mm Diameter wafer and ±5% across a batch of 25 wafers (100mm wafers).	Doping Non-Uniformity: ±5% across 100mm Diameter wafer and ±5% across a batch of 6 wafers (100mm wafers).

2.3. Silicon Nitride LPCVD

Description	Remarks
Contamination Level	Level-2
Pre-process	Level-1 or Level-2 RCA Cleaning
Substrates allowed	Silicon, Silicon Dixode, Quartz and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	25 samples for sample size upto 100mm Diameter wafer
Maximum Temperature	850^0C
Working Pressure	150mTorr to 400mTorr
Available Gases	N_2, $Si_2Cl_2H_2$ and NH_3
Standard recipes available	Si_3N_4: 50nm, 100nm, and 200nm Silicon Rich SiN: 125nm
Thin Film specifications	Refractive Index: 1.99 @ 632nm wavelength Wet Etch Rate(155^0C H_3PO_4): ~5.5nm/min for Si_3N_4 Stress: 1.1GPa (Tensile stress) Film Non-Uniformity: ±3% across 100mm Diameter wafer and ±5% across a batch of 25 wafers (100mm wafers).

2.4. Poly-Silicon LPCVD

Description	Poly-Si (Level 2)	Poly Si/ Si Nano-wires (Level 3)
Contamination Level	Level-2	Level-3
Pre-process	Level-1 or Level-2 RCA Cleaning	RCA Cleaning(Level-1 or Level-2 or Level-3) or Piranha Cleaning(Level-1, Level-2 or Level-3) or Solvent Cleaning(Level-2 or Level-3)
Substrates allowed	Silicon, Silicon Dixode, Quartz and Silicon Nitride	Silicon, Quartz, Glass, Silicon Nitride and Au contaminated samples
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	25 samples for sample size upto 100mm Diameter wafer	25 samples for sample size upto 100mm Diameter wafer
Maximum Temperature	850^0C	850^0C
Working Pressure	150mTorr to 400mTorr	150mTorr to 400mTorr
Available Gases	N_2, H_2 , SiH_4, GeH_4, PH_3 and B_2H_6	N_2, H_2 , SiH_4, GeH_4, PH_3 and B_2H_6
Standard recipes available	Amorphous-Silicon: 50nm and 200nm Poly-Silicon: 50nm, 100nm, 1000nm and 3000nm	Amorphous-Silicon: 50nm and 200nm Poly-Silicon: 50nm, 100nm, 1000nm and 3000nm Silicon Nanowires: Diameter range as 150nm to 300nm and Length of the nanowire as 10µm to 25µm

Thin Film specifications	Refractive Index: 3.8 @ 632nm wavelength Wet Etch Rate(HNA etchant): ~40nm/min Film Non-Uniformity: ±5% across 100mm Diameter wafer and ±5% across a batch of 25 wafers (100mm wafers).	Refractive Index: 3.8 @ 632nm wavelength Wet Etch Rate(HNA etchant): ~40nm/min Film Non-Uniformity: ±5% across 100mm Diameter wafer and ±10% across a batch of 25 wafers (100mm wafers).

2.5. LTO LPCVD

Description	Remarks
Contamination Level	Level-2
Pre-process	Level-1 or Level-2 RCA Cleaning
Substrates allowed	Silicon, Silicon Dixode, Quartz and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	25 samples for sample size upto 100mm Diameter wafer
Maximum Temperature	850^0C
Working Pressure	150mTorr to 400mTorr
Available Gases	N_2, SiH_4, O_2, PH_3 and B_2H_6
Standard recipes available	SiO_2: 100nm and 1000nm
Thin Film specifications	Refractive Index: 1.45 @ 632nm wavelength Wet Etch Rate(BOE etchant): ~150nm/min Film Non-Uniformity: ±5% across 100mm Diameter wafer and ±10% across a batch of 25 wafers (100mm wafers).

2.6. Annealing Furnace

Description	Drive-In Furnace	Metal Anneal Furnace
Contamination Level	Level-1	Level-2(Al, Ti and W only)
Pre-process	Level-1 RCA Cleaning	Solvent Cleaning(Level-3)
Substrates allowed	Silicon, Silicon Dioxide and Silicon Nitride	Silicon, Silicon Dioxide, Quartz and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer	25 samples for sample size up to 100mm Diameter wafer 1 sample for sample size from 100mm to 150mm Diameter wafer
Batch Size	25 samples for sample size up to 100mm Diameter wafer 1 sample for sample size from 100mm to 150mm Diameter wafer	25 samples for sample size up to 100mm Diameter wafer
Maximum Temperature	1100^0C	1100^0C
Working Pressure	Atmospheric Pressure	Atmospheric Pressure
Available Gases	N_2, O_2 and Ar	N_2, FGA(90% $H_2$and 10%N_2) and Ar
Standard recipes available	800^0C in O_2, 1000^0C in O_2, 1000^0C in N_2, 1100^0C in O_2, and 1100^0C in N_2	400^0C in FGA and 450^0C in FGA

2.7. Tempress annealing system

Description	Dielectric Anneal Tempress	Metal Anneal Tempress	PZT contaminated Tempress
Contamination Level	Level 3	Level 3	Level 4
Pre-process	Piranha Cleaning (Level 2) or Solvent Cleaning (Level 2)	Solvent Cleaning (Level 3)	Solvent Cleaning (Level 3)
Substrates allowed	Silicon, Silicon Dixode, Quartz and Silicon Nitride	Silicon, Quartz, Glass, Silicon Nitride and Metal contaminated samples	Silicon, Quartz, Glass, Silicon Nitride, Metal contaminated samples and PZT samples
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer	1cm x 1cm small samples to 100mm Diameter wafer	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	25 samples for sample size upto 75mm Diameter wafer 1 sample for sample size from 75mm to 100mm Diameter wafer	25 samples for sample size upto 75mm Diameter wafer 1 sample for sample size from 75mm to 100mm Diameter wafer	25 samples for sample size upto 75mm Diameter wafer 1 sample for sample size from 75mm to 100mm Diameter wafer
Maximum Temperature	1000^0C	1000^0C	1000^0C
Working Pressure	Atmospheric Pressure	Atmospheric Pressure	Atmospheric Pressure
Available Gases	N_2, FGA(90% $H_2$and 10%N_2), $O_2$and Ar	N_2, FGA(90% $H_2$and 10%N_2), $O_2$and Ar	N_2, FGA(90% $H_2$and 10%N_2), $O_2$and Ar
Standard recipes available	400^0C in FGA, 1000^0C in N_2 and 1000^0C in O_2	400^0C in FGA, 450^0C in FGA, 600^0C in Ar, 1000^0C in N_2 and 1000^0C in O_2	600^0C in Ar and 600^0C in O_2

2.8. Rapid Thermal Processing System

Description	RTP System-1	RTP System-2
Contamination Level	Level-4	Level-1
Pre-process	Solvent Cleaning(Level-3)	Level-1 RCA Cleaning
Substrates allowed	Silicon, Quartz, Glass, Silicon Nitride, Metal contaminated samples and PZT samples	Silicon, Silicon Dixode and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer	1cm x 1cm small samples to 150mm Diameter wafer
Batch Size	5 samples for sample sizes upto 50mm Diameter wafer 1 sample for sample size from 50mm to 100mm Diameter wafer	5 samples for sample sizes upto 50mm Diameter wafer 1 sample for sample size from 50mm to 150mm Diameter wafer
Maximum Temperature	1100^0C	1100^0C
Working Pressure	Atmospheric Pressure	Atmospheric Pressure
Available Gases	N_2, FGA(90% $H_2$and 10%N_2), $O_2$and Ar	N_2, Ar, O_2 and N_2O

Standard recipes available	400^0C in FGA, 450^0C in FGA, 600^0C in Ar, 1000^0C in N_2 and 1000^0C in O_2	2nm, 5nm, 10nm and 20nm
Thin Film specifications	NA	Refractive Index: 1.46 @ 632nm wavelength Wet Etch Rate(BOE): ~70nm/min Film Non-Uniformity: ±3% across 100mm Diameter wafer

2.9. Epitaxial Silicon CVD

Description	Remarks
Contamination Level	Level-2
Pre-process	Level-1 or Level-2 RCA Cleaning
Substrates allowed	Silicon, Silicon Dixode, Quartz and Silicon Nitride
Sample Size	1cm x 1cm small samples to 100mm Diameter wafer
Batch Size	5 samples for sample sizes upto 50 mm diameter wafer 1 sample for sample size from 50 mm to 100 mm Diameter wafer
Maximum Temperature	1100^0C
Working Pressure	6Torr to 60Torr
Available Gases	N_2, H_2 , $Si_2Cl_2H_2$, SiH_4, GeH_4, PH_3 and B_2H_6
Standard recipes available	Intrinsic Poly-Silicon: 1000nm P-doped Poly-Silicon: 1000nm Selective Epitaxial Intrinsic Silicon: 100nm Selective Epitaxial P-doped Silicon: 150nm
Thin Film specifications	Refractive Index: 3.8 @ 632nm wavelength Film Non-Uniformity: ±5% across 100mm Diameter wafer

3. Inline Characterization Bay

3.1. Ellipsometer

Description	Ellipsometer-M2000	IR-VASE Ellipsometer
Contamination Level	Level-Less	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples	Silicon, Quartz, Glass, Silicon Nitride and Metal contaminated samples
Sample Size	1cm x 1cm small samples to 150mm Diameter wafer	1.5cm x 1.5cm small samples to 150mm Diameter wafer
Wavelength Range	245nm to 1000nm wavelength	1.3µm to 30µm wavelength
Thickness measurement	Transparent Thin Films: Upto 10µm Opaque Thin Films: Upto 30nm	Transparent Thin Films: Upto 50µm
Standard recipes available	Different angles: 65^0, 70^0 and 75^0	Different angles: 65^0, 70^0 and 75^0
Standard Models	Available for all the standard Thin Films depositions in NNFC Cleanroom	SiO_2 and SU-8

3.2. Dektak-XT

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Quartz, Glass, Silicon Nitride and Metal contaminated samples
Sample Size	1cm x 1cm small samples to 150mm Diameter wafer
Stylus available	2µm and 12.5µm
Thickness/Etch-Depth measurement	16nm to 500µm
Different measurement modes	2D-Line Scan and 3D-Mapping
Parameters that can be measured	Thickness, Etch-Depth, surface roughness, curvature and Stress

3.3. MOS Ultra Scan

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples
Sample Size	1.5cm x 1.5cm small samples to 200mm Diameter wafer
Different measurement modes	1D-Point scan, 2D-Line Scan and 3D-Mapping
Parameters that can be measured	Bow-Height, Curvature and Stress

3.4. 4-Point Probe System

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples
Sample Size	1 cm x 1 cm small samples to 150 mm Diameter wafer
Different measurement modes	1D-Point scan and 3D-Mapping
Parameters that can be measured	Sheet resistance of the sample/thin film (from 0.01Ω/□ to 80kΩ/□

3.5. MDPmap Lifetime Measurement system

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride, Metal contaminated and Perovskite samples
Sample Size	1.5cm x 1.5cm small samples to 200mm Diameter wafer
Different measurement modes	1D-Point scan and 3D-Mapping
Parameters that can be measured	Minority Charge carrier Lifetime(from 1ns to 1ms)

3.6. Optical Microscope

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples
Sample Size	0.5cm x 0.5cm small samples to 100mm Diameter wafer
Process capability	Optical inspection with Annotation(for 5x, 10x, 20x, 50x, 100x and 150x magnification)

3.7. IV Probe-Station

Description	Remarks
Contamination Level	Level-Less
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples
Sample Size	0.5cm x 0.5cm small samples to 150mm Diameter wafer
Process capability	This is a 20W power supply system with capability for Current and Voltage sweep with the limitation as follows: V-Sweep: 20V with 1A as current compliance and 200V with 100mA as current compliance

3.8. SEM tool

Specification	Gemini Zeiss 500 SEM	Phenom XL G2 Desktop SEM
Filament	Thermal field emission gun	Cerium hexaboride(CeB_6)
Energy	30 keV beam energy	20 keV beam energy
Aperture	10, 20, 30, 60, 120 um	-
Detectors and signals	SE2 detector, Inlens	SE detector Backscattered electron detector Energy-dispersive X-ray (EDS) detector
Substrate Size	Up to 100 mm x 100 mm	Up to 100 mm x 100 mm Up to 40 mm height
Minimum Resolution	≥3 nm	≥10 nm
System Vacuum Time	8 minutes	38 Sec
Imaging	Top view/Cross Section	Top view
Mode of Imaging	Manual	Auto & Manual

4. Dry Etch Bay

4.1. PECVD and ICPCVD systems

Description	PECVD				ICPCVD			
Contamination level	Level 2/3				Level 2			
Gases Available	SiH4, GeH4, CH4, NH3, CF4, N2O, Ar, N2, H2, 2% B2H6 in Ar, 1% PH3 in Ar				NH3, SF6, O2, SiH4, N2O, N2, Ar			
RF Generator	Top Electrode: HF (13.56 MHz, 600W), LF (350 KHz, 500 W) Bottom electrode: No Power				Top Electrode:2 MHz, 3000W Bottom electrode: 13.56 MHz, 600 W			
Table temperature	100 °C to 350 °C				0°C to 400°C			
Pressure	0.2 torr upto 5 torr				2 to 80 mTorr			
Films Deposited	SiO2, SiN, a-Si, and Ge				SiO2, SiNx, SiOxNy and Void free SiO2 Trench Filling			
Sample Size	8-inch				4-inch			
Materials Not allowed	Soda lime glass, SU8, PDMS, PET, Kepton, photoresist				Soda lime glass, SU8, PDMS, PET, kepton, photoresist			
Materials allowed	Si, SiO2, SiN, Ge, a-Si, SOI				Si, SiO2, SiN, Ge, a-Si, SOI			
Recipes	Film	Deposition rate (nm/min)	Refractive Index	Etch non-uniformity across 4-inch wafer	Film	Deposition rate (nm/min)	Refractive Index	Etch non-uniformity across 4-inch wafer
	SiO2	42	1.49	+/- 5%	SiO2 with O2	40	1.47	+/- 5%
	SiN HRI	13	2.03	+/- 7%	SiO2 with N20	28	1.48	+/- 5%
	SiN LRI	14.5	1.94	+/- 7%	SiN	25	1.98	+/- 7%

4.2. RIE Plasma Pro 80 and RIE Corial

Description	RIE Plasma Pro-80	RIE Corial
Contamination Level	Level 3	Level 3
Gases Available	O_2 , Ar, N_2 , SF_6 , CHF_3 and He	BCL3, Cl2, SF6, Ar, He, O2, CHF3, HBr
RF generator	Table Electrode: 13.56MHz 600W	Top Electrode: No powerBottom Electrode: 13.56MHz 600W
Table temperature	·0·C to 80 ·C	0·C to 80·C
Pressure	2mTorr to 60 mTorr	10mTorr to 100 mTorr
Target etch materials	Silicon, Silicon dioxide, Silicon nitride, Nb, NbN, Al2O3	Niobium, Tantalum, Niobium nitride, Dielectrics
Materials not	Gold, SiC , MgO, Cu, PDMS, SU8	Gold, SiC , MgO, Cu, PDMS, SU8

allowed						
Wafer clamping and substrate size	Mechanical Clamping 0.5 x 0.5 cm^2 to 4inch full wafer			Quartz shuttle with 4-inch size		
Recipes	Etch material	Etch rate (nm/min)	Etch non-uniformity across 4-inch wafer	Etch Material	Etch Rate(nm/min)	Etch non-uniformity across 4-inch wafer
	Nb	160	+/- 5%	SiO2	60	+/- 5%
				Ta	60	+/- 5%
				Nb	96	+/- 5%

4.3. DRIE systems

Description	DRIE-SPTS				DRIE-Oxford			
Contamination Level	Level 3a				Level 3a			
Gases Available	SF6, C4F8, O2				SF6, C4F8, O2, CHF3, Ar, CF4			
RF Generator	Top (ICP) electrode: 2MHz, 5KW Bottom electrode: HF (13.56MHz,600W), LF (350-460KHz,300W)				Top (ICP) electrode: 2MHz, 6.5KW Bottom electrode: HF (13.56MHz,1000W), LF (280KHz,500W)			
Table temperature	-10 ^{o}C to 60 ^{o}C.				0^{o}C to 70^{o}C			
Target etch materials	Si				Si (Possibility of SiN and SiO2 etch)			
Materials not allowed	Metal etching and metal exposure to plasma is not allowed				Metal etching and metal exposure to plasma is not allowed			
Wafer clamping and substrate size	4-inch Electrostatic Chuck (Sample size <4" on carrier wafer)				4-inch Electrostatic Chuck (Sample size <4" on carrier wafer)			
Standard recipes	Recipe name	Etch rate (um/min)	Scallops	Etch non-uniformity across 4-inch wafer	Recipe name	Etch rate (um/min)	Scallops	Etch non-uniformity across 4-inch wafer
	NNFC Process BHF	43	1.6 um	+/- 5%	OXF BOSCH DSiE	2.5	<100nm	+/- 5%
	NNFC Process CHF	15	600 nm	+/- 5%				
	NNFC Process ALF	8	110 nm	+/- 5%	SOI DSiE	2.2	<80nm	+/- 5%
	NNFC Process AHF	8.5	200 nm	+/- 5%				

4.4. Plasma Asher

Description	Plasma Asher
Contamination Level	Level 3
Gases Available	O2, Ar, N2 and CF4
RF generator	Bottom electrode: HF (13.56MHz,600W)
Table temperature	Room Temp - 50 ^{o}C.
Pressure	0.1 to 0.25 mbar
Target materials	Si, SiO_2, SIN, GaN, Ga_2O_3, AIN, Al_2O_3, AlGaN, Ti, Cr, TiO_2, HfO2, W, Ta_2O Ge, GeO_2, hBN
Materials not allowed	Only metals mention in above table can be exposed to plasma. Only Au (Gold)

	can be exposed to Low power(<50w) plasma. Ashing is not allowed with Au exposure to the plasma.		
Substrate size	5 mm to 6-inch full wafer		
Recipes	**Ashing recipes**	**Etch rate (nm/min)**	**Etch non-uniformity across 4-inch wafer**
	AZ4562	~250	NA
	AZ5214E	~250	NA
	Descum	~40nm	NA

4.5. RIE systems

Description	RIE-F			RIE-Cl			RIE-X		
Contamination Level	Level 3a			Level 3			Level 4		
Gases Available	O2, Ar, N2, SF6, CF4, CHF3, C4F8			O2, Ar, N2, H2, Cl2, BCl3, CH4, HBr, SF6, CHF3			Cl2, BCl3, C4F8, CHF3, SF6, CF4, O2, Ar, N2		
RF generator	Top (ICP) Electrode: 3000 W, 2 MHz Bottom electrode: 600 W, 13.56 MHz			Top (ICP) Electrode: 3000 W, 2 MHz Bottom electrode: 600 W, 13.56 MHz			Top (ICP) Electrode: 2000 W, 2 MHz Bottom electrode: 600 W, 13.56 MHz		
Table temperature	- 30 °C to 80 °C			- 30 °C to 80 °C			-10 °C to + 60 °C		
Target etch materials	Silicon, Germanium, Oxide, Nitride, Polymer and Dielectrics			Etching of Si, Compound Semiconductors and Metals			PZT, AlN, Al2O3, SiO2, Si, BaTiO3, SrTiO3, Sapphire		
Materials not allowed	Metal etching and metal exposure to plasma is not allowed			Gold, Glass, GaAs, Pt, Bi, MgO, Cu, PZT, InP, Fe, PDMS, SU-8			Gold, SiC , MgO, Cu, PDMS, SU8		
Wafer clamping and substrate size	4-inch mechanical clamp (sample size <4" on carrier wafer)			4-inch mechanical clamp (sample size <4" on carrier wafer)			6-inch Mono-polar electrostatic clamping (sample size <6" on carrier wafer)		
Recipes	Etch Material	Etch Rate(nm/min)	Etch non-uniformity across 4-inch wafer	Etch Material	Etch Rate(nm/min)	Etch non-uniformity across 4-inch wafer	Etch Material	Etch Rate(nm/min)	Etch non-uniformity across 4-inch wafer
	SiO2	190	+/- 5%	SiO2	120	+/- 5%	SiO2	210	+/- 5%
	SiN	750	+/- 5%	GaN	45	+/- 5%	AlN	115	+/- 5%
	Si	1000	+/- 5%	Al	300	+/- 5%	PZT	75	+/- 5%
				AlN	120	+/- 5%			

5. Wet Etch Bay

Chemical Wet benches (CWBs) are classified into 3 groups based on contamination levels, from Level 1 (L1, cleanest) to Level 3 (L3, most contaminated). The specific process capabilities of each level are tabulated below.

Description	Chemical Wet Bench L 1	Chemical Wet Bench L 2	Chemical Wet Bench L3
Substrate Details			
Prime Si/SiO_2 /Quartz wafer	✓	✓	✓
New SOI Wafer	✓	✓	✓
Silicon Nitride	✗	✓	✓
Samples with PR	✗	✓	✓
Glass substrate	✗	✗	✓
Sapphire	✗	✓ (unprocessed)	✓
Samples with Metal	✗	✗	✓
Photoresist in Bath	✗	✗	✗
Tools from which samples are allowed	Level 1 Only	Level 1, Level 2 and Level-less	Except Level 4
Substrate size			
Maximum: 6 inches	✓	✓	✓
Minimum: 0.5 cm*0.5 cm	✓	✓	✓
Cleaning Process			
RCA Bath (100 wafer max)	✓	✓	✗
RCA Beaker	✓	✓	✓
Piranha bath (100 wafer max)	✓	✗	✓
Piranha beaker	✓	✓	✓
Etching Process			
BOE bath	✗	✓	✓
Dil HF bath	✓	✓	✓
Native SiO_2, BSG, PSG	✓	✓	✓
Metal etching: Al, Au, Cr, Pt, Ti, Ag etc.	✗	✗	✓
Metal Dielectric etching: AlN, Al_2O_3, HfO_2 etc.	✗	✗	✓
Silicon (1 µ/min)	✗	✓	✓
Silicon Nitride bath (5 nm/min)	✗	✓	✓
Glass	✗	✗	✓

Note:

BSG- Boro Silicate Glass, PSG- Phospho Silicate Glass

✓ allowed

✗ Not allowed

The following table outlines the specific processes and associated chemicals for the L3 chemical wet benches.

Chemicals Used	Process
L3-CWB Acid Metal	
HCl, H_2O_2, H_2SO_4, NH_4OH, BOE/BHF/HF H_3PO_4. KI, I_2, HNO_3 $AgNO_3$, Acetic acid, Chrome Etchant, Gold and Nickel electroplating solution	Piranha, Metal Etching, Oxide etching of samples containing metal or processed in PECVD and any LEVEL 3 equipment. Glass cleaning using Chromic acid after piranha cleaning. Electroplating Gold by using separate power sources. Dilute HCl treatment before thin film deposition. AlN etching by using Orthophosphoric acid at 80℃. Metal assisted chemical etching (MACE) process to form silicon nanowires by using silver nitrate as raw material. Isotropic silicon etching by HNA (HF: Nitric acid: Acetic acid) etchants. Decontamination processes by treatment of RCA-2 at 80℃ for 20 min. Glass etching using HF. QDR
L3-CWB Solvent/ Metal lift off	
Acetone, IPA, Methanol, Technistrip N155 and P1316	All processes using Acetone, IPA, or methanol. Metal liftoff. Lithography mask cleaning. Techni strip N1555 and P1316 solvents are used at RT to remove PR or liftoff. Ultra sonicators of both low and high frequency for sonication.
L3-CWB - MLO bench	
MLO-07, Acetone,IPA	MLO solvent (DMSO based solvent), which is used by heating up to 70-75° C, to strip the PR and liftoff.
L3-CWB General (BULK processes)	
H_2SO_4, H_2O_2 ,KOH, TMAH, H_3PO_4, Gold and Nickel Electroplating Solution, HCl, BOE/BHF/HF, KI, I_2, $AgNO_3$, Acetic acid, Chrome Etchant: NH_4OH, HNO_3	Si etch using KOH/TMAH either by bath/ beaker. Oxide etching of samples containing metal or processed in PECVD without cleaning the chamber. Electroplating gold and nickel, Glass cleaning using Chromic acid after piranha cleaning. Piranha, Metal Etching, Bulk piranha cleaning for batch wafers (PR contaminated samples are not allowed). Electroplating Gold by using separate power sources. Dilute HCl treatment before thin film deposition. Dielectric etching like oxide and nitride in BOE. AlN etching by using Orthophosphoric acid at 80℃. Metal assisted chemical etching (MACE) process to form silicon nanowires by using silver nitrate as raw material. Isotropic silicon etching by HNA (HF: Nitric acid: Acetic acid) etchants. Glass etching using HF. QDR

HF Vaporizer Bench- L3	
50 % HF	SiO_2 etching HF disposal
Parts Cleaning Bench	
HCl, H_2O_2, H_2SO_4, NH_4OH BOE/BHF/HF H_3PO_4. KI, I_2, $AgNO_3$ Acetic acid, Chrome Etchant, Gold and Nickel Electroplating solution	Piranha, Metal Etching, Oxide etching of samples containing metal or processed in PECVD and any LEVEL 3 equipment. Glass cleaning using Chromic acid after piranha cleaning. Electroplating Gold by using separate power sources. Dilute HCl treatment before thin film deposition. Dielectric etching like oxide and nitride in BOE. AlN etching by using Orthophosphoric acid at 80℃. Metal assisted chemical etching (MACE) process to form silicon nanowires by using silver nitrate as raw material. Isotropic silicon etching by HNA (HF: Nitric acid: Acetic acid) etchants. Decontamination processes by treatment of RCA-2 at 80℃ for 20 min. Glass etching using HF.

Critical Point Drier (CPD):

Description	Remarks
Contamination Level	Leve 4
Substrates allowed	Silicon, Silicon Dioxide, Silicon Nitride and Metal contaminated samples, Glass.
Sample Size	0.5 cm x 0.5 cm small samples to 1 inch Diameter wafer
Process Temperature Range	Room Temperature to 40℃
Gas Lines	Liquid CO_2
Specific Instructions	Use only Metal Tweezes, No acidic residues.

6. Thin Films Bay

6.1. Sputter systems

Description	TECPORT SPUTTER METAL	TECPORT SPUTTER DIELECTRCS	AJA SPUTTER
Contamination Level	Level 3	Level 3	Level 3
Ultimate vacuum	3 E-07 Torr	3 E-07 Torr	5 E-09 Torr
Base Pressure	3 E-06 Torr	3 E-06 Torr	5 E-06 Torr (Load Lock)
Time to achieve base pressure	1hr 15min	1hr 15min	30min (Load Lock)
Substrate heating	600°C max	600°C max	600°C max
Chamber heating	100°C max	100°C max	NA
Power sources	RF, DC and PDC	RF, DC and PDC	DC
Substrate Bias	Possible (1Holder)-DC	Possible (1Holder)-RF	Possible (single holder)-DC/RF
Ion etching	NA	NA	NA
Process gases available	Ar, N2	Ar, O2, N2	Ar, N2, O2(LL)
Sources/Guns	3 Magnetrons -3” Dia	3 Magnetrons -3” Dia	3 Magnetrons – 2” Dia 1 Magnetron – 3” Dia
Substrate loading	Four holders 6” diameter each	Four holders 6” diameter each	1 holder 4” diameter each
Material/Target loading	3 targets (max)	3 targets (max)	4 targets (max)
Substrate rotation	Planetary	Planetary	Uniaxial
Thickness uniformity in stationary mode	Confined to 2” diameter per holder	Confined to 2” diameter per holder	Uniformity across 4”
Precious metal deposition limit	200 nm per holder	200 nm per holder	NA
Minimum Slot Time	3 hours	3 hours	3 hours
Monitored Recipes	Au, Pt, Al, Cr and Ti	ZnO	Nb
Deposition Rate	Au - 0.38nm/sec Pt - 0.27nm/sec Al - 0.33nm/sec Cr - 0.48nm/sec Ti - 0.30nm/sec	ZnO – 0.17nm/sec	Nb – 0.05nm/sec
Film non-uniformity across 4-inch wafer	+/- 15% in stationary mode across 2-inch wafer +/- 15% in rotation mode across 4-inch wafer	+/- 15% in stationary mode across 2-inch wafer +/- 15% in rotation mode across 4-inch wafer	+/- 5% across 4-inch wafer

6.2. Atomic Layer Deposition

Beneq ALD TFS 200	
Contamination Level	Level 3 / 4
Process Available	TiO2, Al2O3
Thickness Range	5 nm – 50 nm
Temperature Range	RT to 400 C
Process Pressure	1 mbar

Substrates Allowed	Si, Glass, Sapphire, Ceramic, Metal
Not Allowed	Photoresists, Polymer Tweezers, Vinyl Gloves
Wafer and substrate	5 x 5 mm2 to 6" (in size)

6.3. Electron Beam Evaporation systems

Description	TECPORT EBE	LEYBOLD EBE	Ferrotec EBE
Contamination Level	Level 3	Level 3	Level 3
Ultimate vacuum	5 E-07 Torr	1 E-07 Torr	5 E-8 Torr
Base Pressure	3 E-06 Torr	1 E-06 Torr	1 E-07 Torr
Time to achieve base pressure	2hr 15min	1hr	30min
Substrate heating	NA	300°C max	NA
Chamber heating	300°C max	NA	150°C max
Power sources	HV DC	HV DC	HV DC
Substrate Bias	NA	NA	NA
Ion etching	Possible	Possible	NA
Process gases available	Ar, O2 and N2	Ar	NA
Sources/Guns	2 electron guns 1 ion gun	1 electron gun 1 ion gun	1 electron gun
Substrate loading	Four holders 4" diameter each	One holder 4" diameter	One Dome 6" diameter – 5 quantities
Material/Target loading	10 crucibles (max)	6 crucibles (max)	6 crucibles (max)
Substrate rotation	Planetary	Uniaxial	Uniaxial
Precious metal deposition limit	100 nm per slot	100 nm per slot	100 nm per slot
Minimum Slot Time	4 hrs	3 hrs	2 hrs
Monitored Recipes	Al2O3 and Al	Al	Al
Deposition Rate	Al2O3 – 0.1nm/sec Al - 0.5nm/sec	Al – 0.2nm/sec	Al – 0.2nm/sec
Film non-uniformity across 4-inch wafer	+/- 5% across 4-inch wafer	+/- 5% across 4-inch wafer	+/- 5% across 6-inch wafer

7. NNFC Annexe

7.1. Annexe Sputter Tools – Table 1

Description	RF Anelva Sputter	VR Tech Sputter Tool	HHV Glovebox Sputter Tool
Ultimate vacuum	1.5E-06 m.bar	9E-07 m.bar	9E-07 m.bar
Base Pressure	2E-06 m.bar	2E-06 m.bar	2E-06 m.bar
Time to achieve base pressure	2hrs 30mins	2 hrs	2hrs 30mins
Substrate heating	NA	300°C max	NA
Chamber heating	300°C max	NA	NA
Power sources	RF	RF & DC	RF/DC/PDC
Substrate Bias	NA	NA	NA – Not Connected
Ion etching	NA	NA	NA
Process gases available	Ar	Ar	Ar, O_2, N_2
Sources/Guns	3 Sputter guns	2 Sputter guns	2 Sputter guns
Substrate loading	One holder – 4" Dia.	One holder – 4" Dia.	One holder – 4" Dia.
Material/Target loading	3 Sputter guns	2 Sputter guns	2 Sputter guns
Substrate rotation	Uniaxial	Uniaxial	Uniaxial
Thickness uniformity in stationary mode	Uniformity across 2” (±5%)	Uniformity across 4” (±10%)	Uniformity across 3” (±5%)
Sample size allowed	5 mm to 50 mm	5 mm to 100 mm	5 mm to 76.2 mm
Precious metal deposition limit	200 nm per slot	200 nm per slot	NA
Minimum Slot Time	4 hrs	4 hrs	4 Hrs
Monitored Recipes	NA	Al	NA
Batch Size	1	1	1
Deposition Rate	Co - 5.8 nm/min MgO - 1.59 nm/min NiFe -5 nm/min SiO_2 - 3.33 nm/min TiO_2 - 5 nm/min Zn – 85.4 nm/min	Al – 10.41 nm/min Au – 16.66 nm/min Cr – 14.3 nm/min Cu – 37.6 nm/min Ni – 8.33 nm/min Pt – 15 nm/min Ti – 6 nm/min	ITO – 4 nm/min IZO – 5.5 nm/min Ta_2O_5 – 10.6 nm/min TiO_2 – 4.7 nm/min

7.2. Annexe Sputter Tools – Table 2

Description	HHV Co-Sputter Oxide Tool	HHV Nitride Sputter Tool	HHV Metal Sputter1
Ultimate vacuum	1.5E-06 m.bar	9E-07 m.bar	3E-07 m.bar
Base Pressure	3E-06 m.bar	4E-06 m.bar	1E-06 m.bar
Time to achieve base pressure	2hrs 30mins	3 hrs	2hrs 30mins
Substrate heating	650°C	650°C	500°C
Chamber heating	NA	NA	NA
Power sources	RF/DC/PDC	DC/PDC	RF/DC
Substrate Bias	NA	NA	NA
Ion etching	NA	NA	NA
Process gases available	Ar, O_2, N_2	Ar, N_2	Ar, O_2, N_2
Sources/Guns	2 Sputter guns	1 Sputter gun	3 Sputter guns
Substrate loading	One holder – 2" Dia.	One holder – 2" Dia.	One holder – 6" Dia.
Material/Target loading	2 Sputter guns	1 Sputter gun	3 Sputter guns
Substrate rotation	NA	NA	Uniaxial
Thickness uniformity in stationary mode	Uniformity across 2" (±5%)	Uniformity across 2" (±10%)	Uniformity across 4" (±5%)
Sample size allowed	5 mm to 50 mm	5 mm to 50 mm	5 mm to 100 mm
Precious metal deposition limit	NA	NA	200 nm per slot
Minimum Slot Time	4 hrs	5 hrs	4 Hrs
Monitored Recipes	TiN & SiO_2	Si_3N_4	Au
Batch Size	1	1	1
Deposition Rate	**OXIDES:** Al_2O_3 – 16.47 (PDC), 35.5 (HiDep.Rate PDC), & 2.42 (RF) nm/min HfO_2 - 5.76 nm/min Nb_2O_5 - 4 nm/min RuO_2 – 3.5 nm/mim SiO_2 – 14.45 (PDC) & 10.74 (RF) nm/min Ta_2O_5 – 16.78 nm/min TiO_2 – 1.03 (Mag1) & 3.55 (Mag2) nm/min WO_3 – 23.62 nm/min ZnO - 1.96 nm/min **METALS/NITRIDES:** AlN – 4.16 nm/min Nb – 60 nm/min Si_3N_4 – 3.7 nm/min TaN – 10 nm/min TiN – 4.44 nm/min	**METALS/NITRIDES:** AlN – 4 nm/min Mo – nm/min Nb – 25 nm/min NbN – 10.74 nm/min Ni - 15 nm/min Si_3N_4 – 20.66 nm/min Ta – 20 nm/min Ti – 15 nm/min TiN – 6.11 nm/min	Al – 5 nm/min Au – 10.6 nm/min Cr – 7.5 nm/min Pt – 25 nm/min Ti – 8.57 nm/min

7.3. Annexe PZT Sputter, Thermal & E-Beam Evaporator Tools – Table 3

Description	HHV Sputter Coater 2	VR Tech Thermal Evaporator	VR Tech E-Beam Evaporator
Ultimate vacuum	3E-07 m.bar	1E-06 m.bar	3E-06 m.bar
Base Pressure	1E-06 m.bar	4E-06 m.bar	E-06 m.bar
Time to achieve base pressure	2hrs 30mins	1 hr 40 mins	2 hr 15 mins
Substrate heating	500°C	600°C	500°C
Chamber heating	NA	NA	NA
Power sources	RF/DC	DC	E-Beam + Thermal
Substrate Bias	NA	NA	NA
Ion etching	NA	NA	NA
Process gases available	Ar, O_2, N_2	For venting - N_2	NA
Sources/Guns	3 Sputter guns	4 electrodes - 2 in use	E-Beam(4) + Thermal(2)
Substrate loading	One holder – 6" Dia.	One holder – 4" Dia.	One holder – 4" Dia.
Material/Target loading	3 Sputter guns	2 filaments	E-Beam(4) + Thermal(2)
Substrate rotation	Uniaxial	Uniaxial	Uniaxial
Thickness uniformity in stationary mode	Uniformity across 4” (±5%)	Uniformity across 4” (±5%)	Uniformity across 4” (±10%)
Sample size allowed	5 mm to 100 mm	5 mm to 100 mm	5 mm to 100 mm
Precious metal deposition limit	200 nm per slot	200 nm per slot	200 nm per slot
Minimum Slot Time	4 Hrs	4 hrs	4 hrs
Monitored Recipes	Au	Al	NA
Batch Size	1	1	1
Deposition Rate	**Materials Available:** PZT – nm/min	**Materials Available:** Ag – 6 nm/min Al – 6 nm/min Au – 6 nm/min Cr – 6 nm/min	**Materials Available:** NA

7.4. Annexe Annealing Tools

Description	Lindberg Furnace	Dry Oxidation Tempress	VR Tech Vacuum Annealing
Ultimate vacuum	NA	NA	2E-06 m.bar
Base Pressure	NA	NA	4E-06 m.bar
Time to achieve base pressure	NA	NA	1 hr 40 mins
Substrate heating	900°C	900°C	600°C
Chamber heating	900°C	900°C	IR Lamp Heating
Power sources	DC	DC	DC
Process gases available	Ar, O_2, N_2 & forming gas	Ar, O_2 & N_2	NA
Substrate loading			One holder – 4" Dia.
Substrate rotation	NA	NA	NA
Thickness uniformity in stationary mode	Uniformity across 4” (±5%)	Uniformity across 4” (±5%)	Uniformity across 4” (±10%)
Sample size allowed	5 mm to 100 mm	5 mm to 100 mm	5 mm to 100 mm
Minimum Slot Time	4 Hrs	4 hrs	4 hrs
Monitored Recipes	NA	NA	NA
Batch Size			1

7.5. Anelva RIE system

Description	Anelva RIE
Ultimate vacuum	2E-6 m.bar
Base Pressure	5E-06 m.bar
Time to achieve base pressure	2 hr
Substrate heating	250°C
Chamber heating	250°C
Power source	RF
Process gases available	Ar, O_2, CF_4
Substrate loading	One holder – 4" Dia.
Substrate rotation	NA
Thickness uniformity in stationary mode	Uniformity across 3” (±10%)
Sample size allowed	5 mm to 76.2 mm
Minimum Slot Time	4 hrs
Monitored Recipes	NA
Batch Size	1
Etch Rate	**Materials Available:** Si_3N_4 – 11 nm/min SiO_2 – 33 nm/min Glass – 34.42 nm/min NbN – 10 nm/min Polymer – 20 min/min TiN – 5.33 nm/min Fused Silica – nm/min

7.6. Chemical Mechanical Polishing

- Real-time monitoring of CoF, pad, slurry, plate, and interface temperatures
- Compatible with wafers up to 4” (100 mm) on a 400 mm polishing plate
- Dual driven arms with independent force and motion control for pad and carrier
- Industry-standard 4.25” diamond pad conditioner for consistent pad performance
- Automated recipe execution with intuitive touchscreen interface and USB data export
- Alkaline colloidal silica. Suitable for polishing silicon wafers and a wide range of optical / electro-optical components-SF1 polishing slurry

Specifications of the tool are listed below:

- Plate speed 100 rpm
- Plate diameter 400mm
- Plate rotation Forward and reverse direction settings
- Carrier 1 speed 10 - 100 rpm
- Carrier 2 speed 10 - 100 rpm
- Max. Carrier 1 back pressure 50 psi/62kPa
- Max. Carrier 2 back pressure 50 psi/62kPa
- Max. Carrier 1 down pressure/load 9 psi/62kPa
- Max. Carrier 2 down pressure load 9 psi/62kPa
- Min. Carrier 1 down pressure/load 0.4 psi/2.8kPa
- Min. Carrier 2 down pressure/load 0.4 psi/2.8kPa
- Carrier sizes available 1”, 4” (wafer size)
- Chemical compatibility Acidic and Alkaline (see Appendix 1 in the tool manual)
- Cabinet details Self-contained chemical-resistant*, bench top cabinet

7.7. Electrochemical workstation

Electrochemical workstation provides several techniques such as cyclic voltammetry, linear sweep Voltammetry, differential pulse voltammetry, square wave voltammetry, Impedance spectroscopy, etc. **Specifications of the tool are listed below**.

FRA (Frequency Response Analyzer), Frequency range	10 micro-Hz and 1 mega - Hz, AC 20 to 100 milli-Amps
Potentiostat 1	± 8 V, ± 300 mA
Booster current	±2 amperes
Potentiostat 2	± 8 V, ± 300 mA

Different measurement modes available in the tool are:

1. General: OC (Open Circuit voltage)

2. DC voltage control

3. DC Current control

4. Impedance voltage control

5. Impedance current control

6. Potentiostatic / Galvanostatic DC Measurements- Anodic oxidation of Nobel metals, electrochemical catalysis

7. Potentiostatic / Galvanostatic Impedance - organic coatings and their adhesion to metal surfaces indirectly study of corrosion

8. Linear sweep Voltammetry/Potentiometry – Electroplating

9. Cyclic Voltammetry/Potentiometry –fuel cells, battery, capacitance, water splitting

10. Normal Pulse Voltammetry/Polarography - Normal Pulse Voltammetry (NPV) is used for both quantitative chemical analysis and to study the mechanism, kinetics, and thermodynamics of chemical reactions. More sensitive compared to non-pulsed

11. Differential Pulse Voltammetry/ Polarography: derivative of Normal pulse voltammetry

12. square wave Voltammetry

13. Staircase Linear Sweep Voltammetry/ Potentiometry

14. Staircase Cyclic Voltammetry /Potentiometry

15. Potential/ Galvanic Pulse

16. Chronoamperometry/ Chronocoulometric and Chronopotentiometry

Some of the process capabilities:

Mode	Process
Potentiostatic/ Galvano static DC Measurements	Metals such as Nickel (Ni) is difficult to oxidise to Ni^{+}. Electrochemistry offers stepwise reduction of metals which are naturally having variable oxidation state.
Potentiostatic/ Galvano staic Impedance	Corrosion study: Corrosion is an electrochemical, or "redox", process involving electron transfer. F measurements in the presence of artificially created corrosion condition environment (Spraying 5 % NaCl solution) can be done.
Linear sweep Voltammetry/Potentiometry	Water splitting reaction: This mode has been used evaluate the activity and efficiency of the catalyst. Sputtered Cobalt Nitrate (CoN). This has been used as electrocatalyst in water splinting. Linear Sweep Voltammetry can be used for electrodeposition of Cu, Au (500 nm thick)
Cyclic Voltammetry/Potentiometry	Currently, 1 to 5-micron Copper metal can be electroplated on the conductive substances using this technique. 3-micron nickel can be electroplated on the conductive substances using this technique.

The reference and counter electrodes available for the process are **Ag/AgCl, Pt, Hg/HgCl.**

7.8. Annexe Optical Lithography System – ABM Mask Aligner

Specification	**ABM** (Manual/Semi-Auto)
Lamp	LED UV (365nm, 405nm)
Lamp Power	LED
Maximum Intensity	42 mW/cm^2
Wavelength	(365nm, 405nm)
Substrate Size	1 cm^2 to 4" Wafer
Minimum CD	≥ 0.5 µm
Exposure Mode	Vacuum Contact, Proximity
Contact modes	Soft, Vacuum, Hard, Proximity
Types of alignment	Top side, Bottom side
Bottom alignment	Objective lens
Backside alignment	Optical light
Alignment Mode	Manual, Automatic

Auto focus	No
Alignment accuracy	Top side: ≤1 um Bottom Side: ≥ 2 um
Stage Movement	Manual
Automatic Stage and WEC correction	Yes
Mask size	5 inches
Photoresists available	S1813, 5214E

7.9. Annexe Acid & Solvent Hoods

Chemical Wet benches (CWBs) are classified into 3 groups based on the chemicals which we used inside the hood. The specific process capabilities of each level are tabulated below.

Description	Acid Hood	Solvent hood 1	Solvent hood 2
Substrate Details			
Prime Si/SiO_2 /Quartz wafer	✓	✓	✓
New SOI Wafer	✓	✓	✓
Silicon Nitride	✓	✓	✓
Samples with PR	✗	✓	✓
Glass substrate	✓	✓	✓
Sapphire	✓	✓	✓
Samples with Perovskites and Heavy metals	✗	✓	✗
Substrate size			
Maximum: 6 inches	✓	✓	✓
Minimum: 0.5 cm*0.5 cm	✓	✓	✓
Cleaning Process			
RCA Beaker	✓	✗	✗
Piranha beaker	✓	✗	✗
Solvent cleaning	✗	✓	✓
PR removal	✗	✓	✓
Lift off	✗	✓	✓
Etching Process			
BOE etching	✓	✗	✗
Dil HF dip	✓	✗	✗
Native SiO_2, BSG, PSG	✓	✗	✗
Metal etching: Al, Au, Cr, Pt, Ti, Ag etc.	✓	✗	✗
Metal Dielectric etching: SiO_2, Al_2O_3, HfO_2 etc.	✓	✗	✗
Silicon (1 µ/min)	✓	✗	✗

Note: BSG- Boro Silicate Glass, PSG- Phospho Silicate glass

✓ allowed ✗ Not allowed

The following table outlines the specific processes and associated chemicals for the L3 chemical wet benches.

Chemicals Used	Process
Acid Hood	
HCl, H_2O_2, H_2SO_4, NH_4OH, BOE/BHF/HF H_3PO_4. KI, I_2, HNO_3 $AgNO_3$, Acetic acid, Chrome Etchant, KOH	Piranha, Metal Etching, Oxide etching of samples containing metal. Glass cleaning using Chromic acid after piranha cleaning. Electroplating Gold by using separate power sources. Dilute HCl treatment before thin film deposition. AlN etching by using Orthophosphoric acid at 80℃. Isotropic silicon etching by HNA (HF: Nitric acid: Acetic acid) etchants. Decontamination processes by treatment of RCA-2 at 80℃ for 20 min. Glass etching using HF. Si etch using KOH by beaker.
Solvent Hood 1	
Acetone, IPA, Methanol, Gold and Nickel electroplating solution, Cu electroplating Solution Technistrip N155 and P1316	All processes using Acetone, IPA, or methanol. Metal liftoff. Electroplating Gold by using separate power sources. Lithography mask cleaning. Techni strip N1555 and P1316 solvents are used at RT to remove PR or liftoff. Ultra sonicators of both low and high frequency for sonication.
Solvent Hood 2	
MLO-07, Acetone, IPA, Gold and Nickel electroplating solution, Cu electroplating Solution. Technistrip N155 and P1316	MLO solvent (DMSO based solvent), which is used by heating up to 70-75° C, to strip the PR and liftoff. Electroplating Gold by using separate power sources.

8. Description of revision history

Issue No. 01 Version No.00	Initial release
Issue No. 01 Version No.01	Added Ferrotec tool specification under 6.3